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TITLE: GEOGRAPHIC APPLICATIONS OF ERTS-1 IMAGERY TO RURAL LANDSCAPE CHANGE (162-III)

PRINCIPAL INVESTIGATOR:
Dr. John B. Rehder
Department of Geography
University of Tennessee
Knoxville, Tennessee 37916

SUMMARY: The research project is designed for the monitoring and delimiting of rural landscape changes in eastern Tennessee through the interpretation of ERTS-I imagery. High altitude imagery (RB-57 1:120,000), low altitude imagery (1:10,000), and ground truth data are integrated into the investigation for control and further interpretation. The study area, centered on Knoxville, Tennessee, encompasses a 10,000 square mile area in which two specific test sites are located. One, a 14 x 14 mile site on the Cumberland Plateau, is for use in observing forest and strip mining changes. The other test site (16 x 21 miles) is centered on Knoxville for use in investigating urban and suburban encroachment on rural landscapes. The ultimate objective of the investigation is to identify, delimit, and map dynamic photomorphic regions of landscape changes; specifically: (1) areas of forest alteration/newly cleared land, (2) areas which exhibit dynamic agricultural landuse change during the seasonal-annual cycle, (3) gross patterns of constructive non-agricultural change, e.g. roads, new settlements, new construction, and (4) sites of destructive alterations of physical and cultural landscapes, e.g. natural and man-made hazards of flood, fire, erosion.

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REMOTE SENSING OF LANDSCAPE CHANGE: A CASE FOR THE EARTH RESOURCES TECHNOLOGY PROGRAM

Dr. John B. Rehder
Department of Geography
University of Tennessee
Knoxville, Tennessee

On Sunday, July 23, 1972, NASA's Earth Resources Technology Satellite or ERTS-I was placed into a sun-synchronous orbit 560 miles above the earth's surface. With that successful launch was the launching of a renewed program in the remote sensing of the earth from spacecraft. Sensors on ERTS-I include three return beam vidicon cameras which operate much like T.V. cameras in the blue-green, green-yellow, and red-infrared bands (475-830 nanometers) and a multi-spectral scanner system which operates in four channels from 500 to 1100 nanometers. Data gathered by these sensors are transmitted principally to Goddard Space Flight Center at Greenbelt, Maryland where the digital inputs are processed into photographic imagery and digital tapes. The data which our particular project is utilizing are primarily in the form of photographic images in 70 mm and 9½" x 9½" formats in both black and white and color.

The test area is a 10,000 square mile area centered on Knoxville, Tennessee. It extends north-south from southernmost Kentucky to about 50 miles south of Knoxville, and east-west from western North Carolina to Crossville, Tennessee on the Cumberland Plateau.

Although the overall project has just begun, initial activity has been to establish a procedure in multi-stage sampling. This involves the generation of low altitude aircraft imagery at 1:31,680 scale using the research aircraft at the University of Tennessee, the acquisition of high altitude aircraft imagery at 1:120,000 scale supplied by NASA's RB-57 aircraft, and the satellite imagery of 1:1 million scale supplied by ERTS-I. Using techniques of comparison, the aim has been to analyze each scale of the imagery proceeding from smallest to largest and ultimately in some cases to ground truth in order to inventory various selected elements of potential landscape change. These elements include forest cover, agricultural landuse, strip mining, resort development, urban growth, and highway development.

From ERTS-I imagery, as one might expect, relatively large resolution objects such as major streams and TVA reservoirs, interstate highways, urban concentrations, and areas of timber cover with contrasting strip mine scars can be clearly seen. From the intermediate scale imagery, many more resolution cells of information can be seen such as dams, construction sites, suburban developments, individual strip mining scars, again forest cover in greater detail to the point of identifying forest types, and individual fields in the agricultural scene plus many more. From the low altitude imagery (1:31,680) objects of smaller resolutions similar to those found on conventional black and white aerial photography can be detected. Anything from individual trees, to cars, to swimming pools and their occupants can be seen.

What we have outlined here, then, are three different stages of altitude and their respective spatial scales for the remote sensing of a portion of the earth's surface. These represent only static slices of time: the low altitude imagery generated in June, July, and August of this year, the intermediate scale in April, and the satellite data from August until present.

But what about the temporal variable, the time element which is so vital to the study of landscape change? One indeed minimally requires a before and after picture. ERTS-I, which provides complete coverage of the United States every 18 days is more than adequate for this purpose. Imagine, a new set of imagery every 18 days or 20 sets per year covering on a <u>single</u> image frame 10,000 square miles. Because of this immediacy of current coverage and the scale involved, ERTS-I far exceeds the temporal performance of the aircraft platforms. From the intermediate scale RB-57 program, we may consider ourselves fortunate to have just one set of imagery at 1:120,000 within a single year. NASA's aircraft program is that much in demand. Furthermore, nearly 300 images must be generated in order to cover the same area as a single frame from ERTS. The lower aircraft imagery generated by our own research Aero-Commander is capable of being produced more often but to cover 10,000 square miles every 18 days is next to impossible for this plane. Incidentally, four overflights, 600 images, and nearly all summer were required to cover a mere 336 square mile area in west Knox County!

ERTS-I, then, is a quick, reliable system for producing the big picture view at regular intervals and thus is spatially and temporally the best method for detecting, delimiting, and monitoring gross patterns of landscape change in eastern Tennessee.

As for findings thus far in the project, several potentially dynamic areas and large scale sites have been delimited for closer analysis. Slide one illustrates several of the resort development schemes located on the Cumberland Plateau. The resorts of Renegade, Lake Tansi, Holiday Hills and Fairfield Glade illustrate the saturation of resorts which is taking place on the plateau landscape. Obviously, this is a case for monitoring the internal and external landscape and landuse changes here. The next slide illustrates the suburban growth areas of West Knox County. Not only are large tracts of land being cleared for suburban housing, but also a number of tracts are being developed for shopping centers and new car dealerships.

(Next slide). Here we have a devestated strip mining landscape on the Cumberland Plateau. Forest changes of a severe magnitude in addition to the strip mining scars are clear evidence of landscape alteration. One, however, must be cautious in interpreting photos of this kind because recently abandoned strip mine areas do not appear much different from active ones. Here is where ground truth field checking and low altitude aircraft overflights are of utmost significance.

In conclusion, the use of a single remote sensing platform, sensor, or even program is no panacea for the study of the earth's surface. We merely have the technology to gather the data and in a rather crude sense to mechanically interpret the data. The new frontier in remote sensing lies in the hands of the interpreter whether he is an image specialist or a farmer reading his own farm landscape from a hand-held photo or you the geographic audience — perhaps the best single collective force of landscape and image interpreters in the world.